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TRUCK SHIPPING TESTS WITH LONG ISLAND CAULIFLOWER, 1953

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INTRODUCTION

In previous truck shipping tests with crated cauliflower, begun in 1950,2/ it was determined (1) that lengthwise loading was preferable to crosswise loading because of faster cooling, (2) that as soon as possible after loading the trucks should be initially iced, and (3) that 3/4-inch floor racks did not permit adequate air circulation beneath the load to cool the bottom layer. In continued tests in 1953 in cooperation with the Atlantic Commission Company,3/ reported herein, special emphasis was placed on (1) devising a load pattern to permit faster and more uniform cooling and (2) determining the value of bunker icing in addition to top icing in refrigerating the loads.4/

METHODS

Ten truck shipments were made in October and two in November, all to southern markets. Loading and shipping data for all 12 trucks are presented in table 1. Although the paired trucks did not go to the same destinations, those in each pair can be compared rather accurately during the first 42 or 48 hours of transit when they followed approximately the same routes. Discussions of the tests, tables, and figures were therefore generally limited to this period. Most of the trailers were about 30 feet long and had metal-covered side walls 2 inches thick, including insulation. Each trailer contained an ice bunker located in the forward end and had a fan at top center, driven by a gasoline motor on the outside. The trucks were also equipped with vents. The drivers were instructed to keep the vents closed and the fans operating during the transit period. Four of the twelve test trucks had 3/4-inch built-in floor racks. Previous results determined that racks of this size have practically no effect on air circulation.

1/ Report of a study made under the Agricultural Marketing Act of 1946, formerly project RM:a 165. Part of the Northeastern Regional project (NEM-3) on studies of merchandising and consumer acceptance, maintenance of quality and condition, and the development of quality tests for vegetables marketed in the Northeast.

2/ Kaufman, J. and Hruschka, H. W. Truck Shipping Tests with Long Island Cauliflower, 1950-52. U. S. Dept. Agr. H. T. & S. Office Report No. 291, April 1953 (Processed).

3/ Now the National Produce Division of The Great Atlantic and Pacific Tea Company.

4/ The authors are grateful to J. M. Lutz and W. H. Redit, Agricultural Marketing Service, for helpful suggestions.

It was planned to have all trucks loaded lengthwise, but some crosswise-loaded trucks had to be included because some of the drivers objected to the decreased pay-load space in this type of load. In the lengthwise load the crates were placed lengthwise of the truck usually 6 across (fig. 1). In the crosswise loads the crates were placed at right angles to the length of the truck, 3 across plus one lengthwise row (fig. 2). In some trucks the conventional lengthwise load was modified by the removal of one row of crates from the bottom layer and spacing the remaining 5 rows of crates to provide air channels (fig. 3). In all types of loads the Long Island wirebound crates were placed on their sides, 5 high. Ten trucks carried other vegetables in addition to 200 to 325 crates of cauliflower (table 1).

Most of the loads were cooled by crushing 300-pound cakes of ice (snow ice) and blowing the ice on top of the load. Five of the trucks were bunker-iced in addition to being top-iced. All trucks received their initial icing at Riverhead, Long Island, and most trucks were re-iced several times in transit (table 1).

Continuous records of transit temperatures were obtained from recording thermometers which were placed inside crates in the top, middle, and bottom layers of the fourth-stack centerline position in each truck as the trucks were loaded. The transit period generally was from 42 to 60 hours.

RESULTS

The temperature data from the 12 trucks are summarized in table 2 and are illustrated graphically in figures 4-9. Terminal data were submitted by the receiver or the driver.

Top Icing vs. Top and Bunker Icing in Crosswise Loads

Trucks 1 and 2 were loaded during relatively warm weather with an average temperature of 66° F. Even though top-iced truck 1 was more heavily iced in transit, cooling in top- and bunker-iced truck 2 was better (table 2, fig. 4). The average temperature 42 hours after loading was 9° lower and the bottom temperature 4° lower in truck 2 than in truck 1.

Crosswise vs. Modified Lengthwise Loading in Top- and Bunker-Iced Trucks

During the first 24 hours trucks 3 and 4 (table 1) received about the same amount of top ice and during this period temperatures were similar. However, both the top and bunker of truck 4 (lengthwise load) were re-iced en route, whereas only the bunker was re-iced in truck 3. As soon as the top ice was depleted, therefore, the commodity temperatures in all layers of truck 3, especially that of the bottom layer, began to rise (table 2, fig. 5). The bunker ice alone was insufficient to maintain low temperatures in the bottom layer of the load.

Modified Lengthwise vs. Crosswise Loading in Top-Iced Trucks

Trucks 5 and 6 were loaded when the outside temperature averaged 73° F. and the commodity temperature about 65°. The modified lengthwise load (truck 5) averaged 10° lower temperatures after the first 6 hours (table 2, fig. 6) than that of the crosswise load (truck 6). Both trucks received about the same amount of top-ice by midnight, the day of loading, but during the latter part of the trip the modified load (truck 5) was not as well iced (table 1) as the crosswise load (truck 6) and arrived with no top ice. Even better temperatures would doubtless have been obtained if the modified load had been iced better.

Modified vs. Conventional Lengthwise Loading in Top-Iced Trucks

Two tests (tests 4 and 5) were made to compare modified and conventional lengthwise methods of loading. Trucks 7 and 8 were sent out October 20, trucks 9 and 10 on October 26. In test 4, the modified lengthwise load (truck 7) cooled faster and maintained lower temperatures in transit than truck 8, the conventional lengthwise load (table 2, fig. 7). After 6 hours the difference between the bottom layers was 8° F. and varied between 4° and 8° during most of the transit period. The average temperature difference for the trip in all positions was 4°. The high transit temperatures of truck 8 may be due partly to insufficient top icing during the latter part of the trip. This truck was initially iced the same as truck 7 but arrived with many bare spots.

Trucks 9 and 10 were loaded with relatively cool cauliflower. Commodity temperature averaged about 54°F. In this test, too, the cooling was better in the modified than in the conventional load. After the first 6 hours, the average temperature for the 3 positions in the modified load was 43° and that for the conventional load was 51° (fig. 8). After the first 18 hours they were only about 4° apart. The total ice supplied for the two trucks was about the same, but, because of greater meltage in the modified lengthwise load, there was less ice remaining in this load at the end of the trip. The difference in temperature probably would have been greater had the driver top-iced the modified load more thoroughly in transit. The load arrived with the first four stacks free of top ice (the fourth stack contained the test packages).

Conventional Lengthwise vs. Modified Lengthwise in Top- and Bunker-Iced Trucks

Truck 12 was loaded by the modified lengthwise method and truck 11, by the conventional lengthwise method. Truck 12 should have arrived with better temperatures than truck 11, but the driver, fearing a penalty for overweight on the front axle in Virginia, disposed of the ice at (or near) Washington, D. C.; he later re-iced the load, using a total of 14,700 pounds of ice. The records show practically no change in the middle and bottom layer temperatures although there was an 8° F. reduction in the top layer during transit. On the other hand, truck 11 (conventional lengthwise), using a total of only 11,600 pounds of ice, showed more or less steady cooling of the load to an average temperature of 41° in the middle and bottom layers after 48 hours.

DISCUSSION AND CONCLUSIONS

Low transit temperatures are highly desirable in insuring adequate shelf life of cauliflower in retail stores; high transit temperatures may cause it to arrive in poor condition at the terminal market.

Claypool, Morris, Pentzer, and Barger stated that cauliflower is highly perishable and recommended 32° F. for transit temperatures with a permissible range of 32° to 50° for 48 hours.[5] In tests conducted by this laboratory, it was found that cauliflower held up only 1 day at 68° F., 3 days at 50° and 10 days at 32°. The evidences of deterioration were leaf yellowing, leaf abscission, and curd spotting by the bacterial soft rot organism and Alternaria.[6]

The conventional lengthwise loads, which are more open than the crosswise loads (fig. 1 and 2) and permit more ice to come in contact with the cauliflower, had somewhat lower temperatures. The modified lengthwise load (fig. 3) permits even better cooling by providing more air channels at the bottom of the load where cooling is generally slowest. In the present series of tests, the modified lengthwise loads cooled faster and had about 4° F. lower transit temperatures than conventional lengthwise loads, when both were iced similarly with top ice only.

Bunker icing in addition to top icing resulted in better temperatures than top icing alone in the one test in which these two services were compared.

5/ Claypool, L. L., Morris, L. L., Pentzer, W. T., Barger, W. R. Air Transportation for Fruits, Vegetables and Cut Flowers: Temperature and Humidity Requirements and Perishable Nature. U. S. Dept. of Agric. and California Agric. Expt. Sta., H. T. & S. Office Report No. 258. October 1951.

6/ Hruschka, H. W., and Kaufman, J. Storage Tests with Long Island Cauliflower. From unpublished report, N. Y. Market Pathology Laboratory. 1948.

Table 1.- Loading, shipping, and icing of cauliflower shipped by truck from Long Island to specified destinations, 1953

Item	Unit	Truck identification 1	2	3	4	5	6
Destination		Tampa, Fla.	Raleigh, N.C.	Charlotte, N.C.	Jacksonville, Fla.	Raleigh, N.C.	Tampa, Fla.
Date							
Shipped		Oct. 12	Oct. 12	Oct. 13	Oct. 13	Oct. 19	Oct. 19
Unloaded		Oct. 14	Oct. 14	Oct. 15	Oct. 15	Oct. 21	Oct. 21
Average temperature							
Air							
Loading	°F	67	65	57-65	57-65	73	73
Unloading 1/	°F	80		72	77	68	75
Commodity							
Loading	°F	60	62	49	49	64	65
Unloading	°F	49	2/45	45	35	48	55
Type of load		Crosswise	Crosswise	Crosswise	Modified lengthwise	Modified lengthwise	Crosswise
Packages per load							
Cauliflower	No.	250	325	200	300	200	275
Other	No.	170	120	315	104	180	170
Thickness of floor racks	In.		3/4			3/4	3/4
Icing							
Initial							
Top	Lb.	1800	3600	3600	2400	2100	3000
Bunker	Lb.	0	1500	1500	1800	0	0
Re-icing							
First							
Top	Lb.	4/3000	2100	0	1200	3000	1500
Bunker	Lb.	0	1200	1200	600	0	0
Other							
Top	Lb.	9200	3600	0	3600	1200	5400
Bunker	Lb.	0	1200	0	3000	0	0
Total icing							
Top	Lb.	14,000	9300	3600	7200	6300	9900
Bunker	Lb.	0	3900	2700	5400	0	0
Top ice remaining 1/	Lb.	2100	1400	Practically	4200	0	2100

See footnotes at end of table

-continued-

Table 1.- Loading, shipping, and icing of cauliflower shipped by truck from Long Island to specified destinations, 1953 - continued

Item	Unit	Truck identification					
		7	8	9	10	11	12
Destination		Birmingham, Ala.	Jacksonville, Fla.	Jacksonville, Fla.	Tampa, Fla.	Tampa, Fla.	Atlanta, Ga.
Date							
Shipped		Oct. 20	Oct. 20	Oct. 26	Oct. 26	Nov. 2	Nov. 2
Unloaded		Oct. 23	Oct. 23	Oct. 28	Oct. 29	Nov. 5	Nov. 4
Average temperature							
Air							
Loading	°F	70	65	63	63	67	67
Unloading 1/	°F	70			63		70
Commodity							
Loading	°F	65	66	54	55	53	55
Unloading	°F	47	53	37	39	2/41	3/53
Type of load		Modified lengthwise	Lengthwise	Modified lengthwise	Lengthwise	Lengthwise	Modified lengthwise
Packages per load							
Cauliflower	No.	378	225	325	210	250	392
Other	No.	0	135	82	195	165	0
Thickness of floor racks	In.	3/4					
Icing							
Initial							
Top	Lb.	3000	3000	3000	3000	2100	2400
Bunker	Lb.	0	0	0	0	1200	1200
Re-icing							
First							
Top	Lb.	1800	2400	2700	2700	3300	5100
Bunker	Lb.	0	0	0	0	0	3000
Other							
Top	Lb.	8400	2400	2700	3000	4000	2100
Bunker	Lb.	0	0	0	0	1000	900
Total icing							
Top	Lb.	13,200	7800	8400	8700	9400	9600
Bunker	Lb.	0	0	0	0	2200	5100
Top ice remaining 1/	Lb.	2800	1500	5/2000	2100	-	3500

1/ Reported by receiver or driver at destination.
2/ Average for 2 positions.
3/ The driver opened all vents for 7½ hours at Washington to melt all the ice.
4/ Second re-icing with 2,400 pounds followed shortly thereafter.
5/ First 4 rows in front had no top ice on arrival.

Table 2.- In-transit temperatures of commodities as influenced by type of load and icing, 1953

Item	Date shipped	Type of - Load	Type of - Icing	Temperature indicated period after loading: 0 hrs. °F	6 hrs. °F	12 hrs. °F	18 hrs. °F	24 hrs. °F	30 hrs. °F	36 hrs. °F	42 hrs. °F	48 hrs. °F	54 hrs. °F	60 hrs. °F	Average temperature for first 42 or 48 hours °F
Truck No. 1	Oct. 12	Crosswise	Top												
Location of thermometer in load															
Top				60	42	41	43	43	47	50	53	52	45	--	47
Middle				59	53	51	50	50	50	50	51	51	51	--	52
Bottom				59	58	56	55	53	53	52	52	52	53	--	55
Average 1/				60	50	48	49	48	50	51	53	52	49		
Truck No. 2	Oct. 12	Crosswise	Top and bunker												
Location of thermometer in load															
Top				62	38	38	41	40	40	42	41	--	--	--	43
Middle				62	2/	2/	2/	2/	2/	2/	2/				--
Bottom				62	57	55	50	50	51	52	48	--	--	--	53
Average 1/				62	48	46	46	45	46	47	44				
Truck No. 3	Oct. 13	Crosswise	Top and bunker												
Location of thermometer in load															
Top				48	37	34	33	33	36	38	39	39	--	--	37
Middle				48	43	42	39	39	44	45	46	44	--	--	43
Bottom				49	45	45	43	45	50	50	49	52	--	--	48
Average 1/				48	42	40	38	39	43	44	45	45			

See footnotes at end of table.

-continued-

Table 2.- In-transit temperatures of commodities as influenced by type of load and icing, 1953. -continued.

Item	Date shipped	Type of- Load	Type of- Icing	Temperature indicated period after loading: 0 hrs. °F	6 hrs. °F	12 hrs. °F	18 hrs. °F	24 hrs. °F	30 hrs. °F	36 hrs. °F	42 hrs. °F	48 hrs. °F	54 hrs. °F	60 hrs. °F	Average temperature for first 42 or 48 hours °F
Truck No. 4	Oct. 13	Modified length-wise	Top and bunker												
Location of thermometer in load															
Top				48	36	34	33	33	34	34	33	34	--	--	35
Middle				51	42	39	39	38	36	35	34	34	--	--	39
Bottom				48	44	42	42	41	40	38	38	38	--	--	41
Average 1/				49	41	38	38	37	37	36	35	35			
Truck No. 5	Oct. 13	Modified length-wise	Top												
Location of thermometer in load															
Top				64	43	42	42	48	49	50	50	--	--	--	48
Middle				63	49	49	47	44	44	45	46	--	--	--	48
Bottom				64	56	58	56	55	48	49	48	--	--	--	54
Average 1/				64	49	50	48	49	47	48	48				
Truck No. 6	Oct. 19	Crosswise	Top												
Location of thermometer in load															
Top				64	53	48	46	39	40	41	43	51	51	--	47
Middle				65	62	59	56	56	58	59	58	56	52	--	59
Bottom				65	63	57	56	60	61	61	62	63	61	--	61
Average 1/				65	59	55	53	52	53	54	54	57	55		

See footnotes at end of table.

-continued-

Table 2.- In-transit temperatures of commodities as influenced by type of load and icing, 1953 - continued.

Item	Date shipped	Type of- Load	Type of- Icing	Temperature indicated period after loading: 0 hrs. °F	6 hrs. °F	12 hrs. °F	18 hrs. °F	24 hrs. °F	30 hrs. °F	36 hrs. °F	42 hrs. °F	48 hrs. °F	54 hrs. °F	60 hrs. °F	Average temperature for first 42 or 48 hours °F
Truck No. 7	Oct. 20	Modified length-wise	Top												
Location of thermometer in load															
Top				65	42	44	48	52	45	46	47	39	42	35	48
Middle				64	54	52	50	53	52	51	50	48	44	40	53
Bottom				65	57	57	56	56	55	53	52	51	47	45	56
Average 1/				65	51	51	51	54	51	50	50	46	44	40	
Truck No. 8	Oct. 20	Length-wise	Top												
Location of thermometer in load															
Top				65	44	48	54	48	49	50	51	45	51	54	50
Middle				66	60	58	57	54	53	54	54	54	54	53	57
Bottom				66	65	62	61	60	59	58	58	55	53	53	60
Average 1/				66	56	56	57	54	54	54	54	51	53	53	
Truck No. 9	Oct. 26	Modified length-wise	Top												
Location of thermometer in load															
Top				53	39	36	35	35	35	35	36	--	--	--	38
Middle				54	43	41	38	37	37	36	36	--	--	--	40
Bottom				54	46	44	39	40	40	39	39	--	--	--	43
Average 1/				54	43	40	37	37	37	37	37				

See footnotes at end of table.

-continued-

Table 2.- In-transit temperatures of commodities as influenced by type of load and icing, 1953 - continued.

Item	Date shipped	Type of- Load	Type of- Icing	Temperature indicated period after load 0 hrs. °F	6 hrs. °F	12 hrs. °F	18 hrs. °F	24 hrs. °F	30 hrs. °F	36 hrs. °F	42 hrs. °F	48 hrs. °F	54 hrs. °F	60 hrs. °F	Average temperature for first 42 or 48 hours °F
Truck No. 10	Oct. 26	Length-wise	Top												
Location of thermometer in load															
Top				55	49	43	36	35	36	37	38	38	39	--	41
Middle				55	50	46	42	39	38	36	36	36	36	--	43
Bottom				56	54	50	46	44	42	41	42	41	41	--	47
Average 1/				55	51	46	41	39	39	38	39	38	39		
Truck No. 11	Nov. 2	Length-wise	Top and bunker												
Location of thermometer in load															
Top				53	3/	3/	3/	3/	3/	3/	3/	3/	3/		
Middle				52	49	46	46	46	41	40	37	35	35	--	44
Bottom				55	54	54	55	56	55	52	49	47	46	--	53
Average 1/				54	52	50	50	51	48	46	43	41	41		
Truck No. 12	Nov. 2	Modified length-wise	Top and bunker												
Location of thermometer in load															
Top				56	55	51	49	47	45	43	43	43	--	--	48
Middle				55	54	54	53	52	52	52	51	51			53
Bottom				55	55	56	55	54	55	56	55	54	--	--	55
Average 1/				55	55	55	54	53	54	54	53	52			

1/ Average for 2 positions.
2/ Instrument failed to record.
3/ Instrument failed to record properly. Pen reached 34°F.

Figure 1. - Conventional lengthwise load.

Figure 2. - Crosswise load.

Figure 3 - Modified lengthwise load.

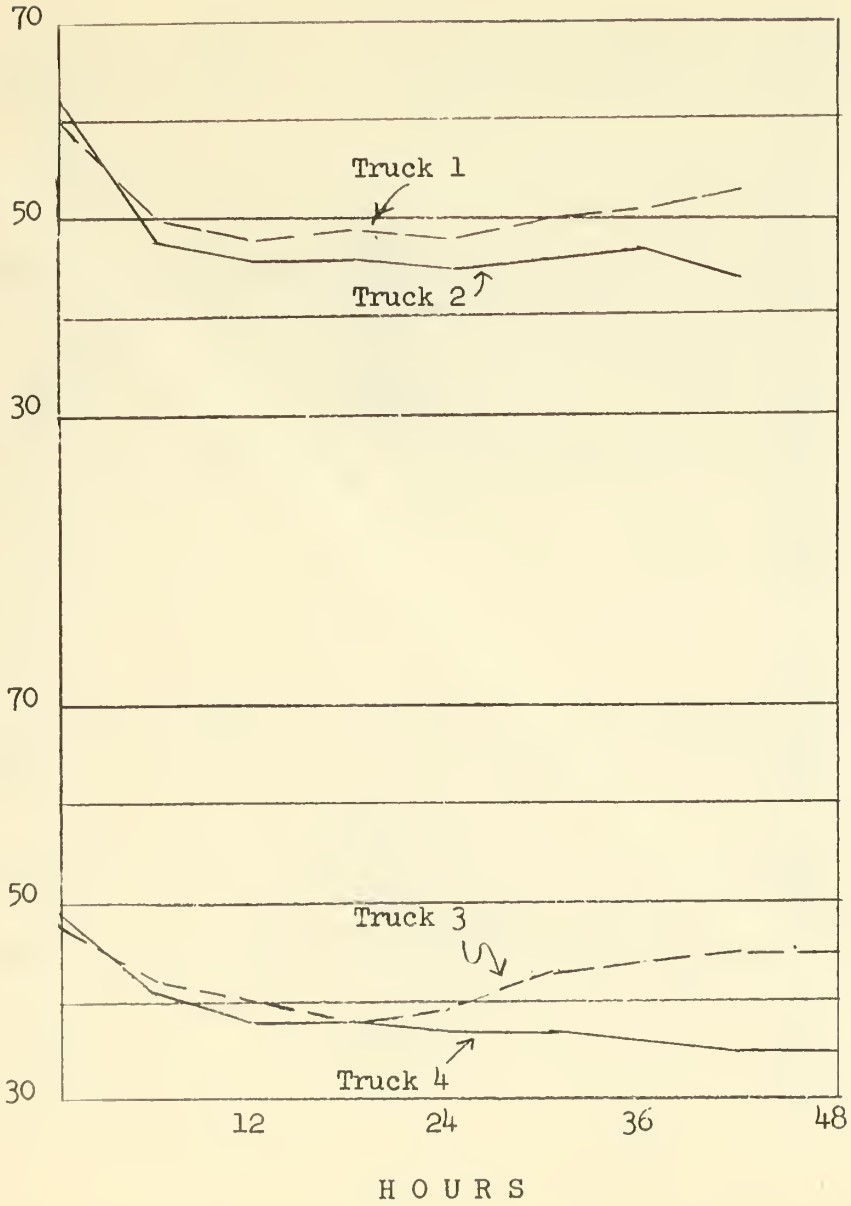

Figure 4.

Transit temperatures (average for two positions) in a crosswise, top-iced load (truck 1) and in a crosswise top- and bunker-iced load (truck 2), October 1953.

Figure 5.

Transit temperatures (average for three positions) in a crosswise top- and bunker-iced load (truck 3) and in a modified lengthwise top- and bunker-iced load (truck 4), October 1953.

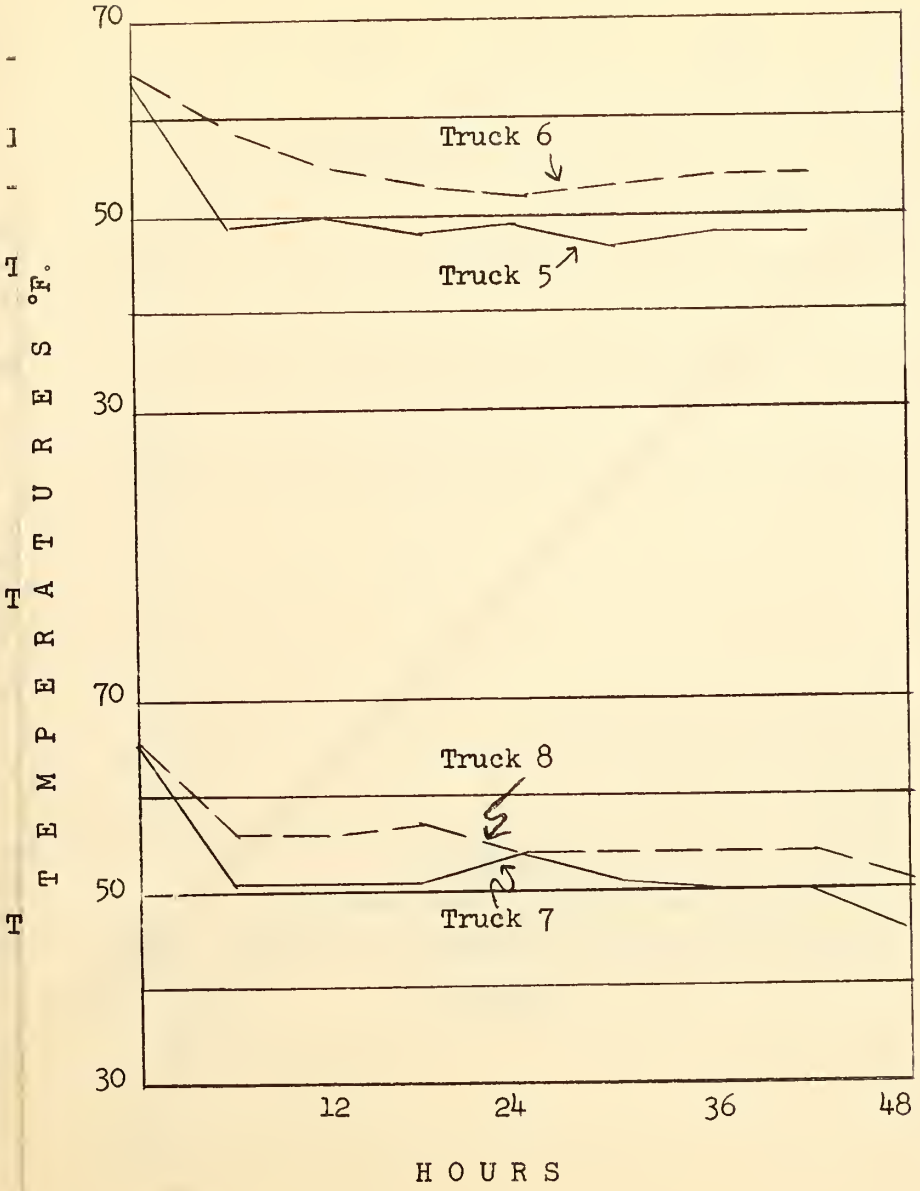

Figure 6.

Transit temperatures (average for three positions) in a modified lengthwise top-iced load (truck 5) and in a crosswise top-iced load (truck 6), October 1953.

Figure 7.

Transit temperatures (average for three positions) in a modified lengthwise top-iced load (truck 7) and in a conventional lengthwise top-iced load (truck 8), October 1953.

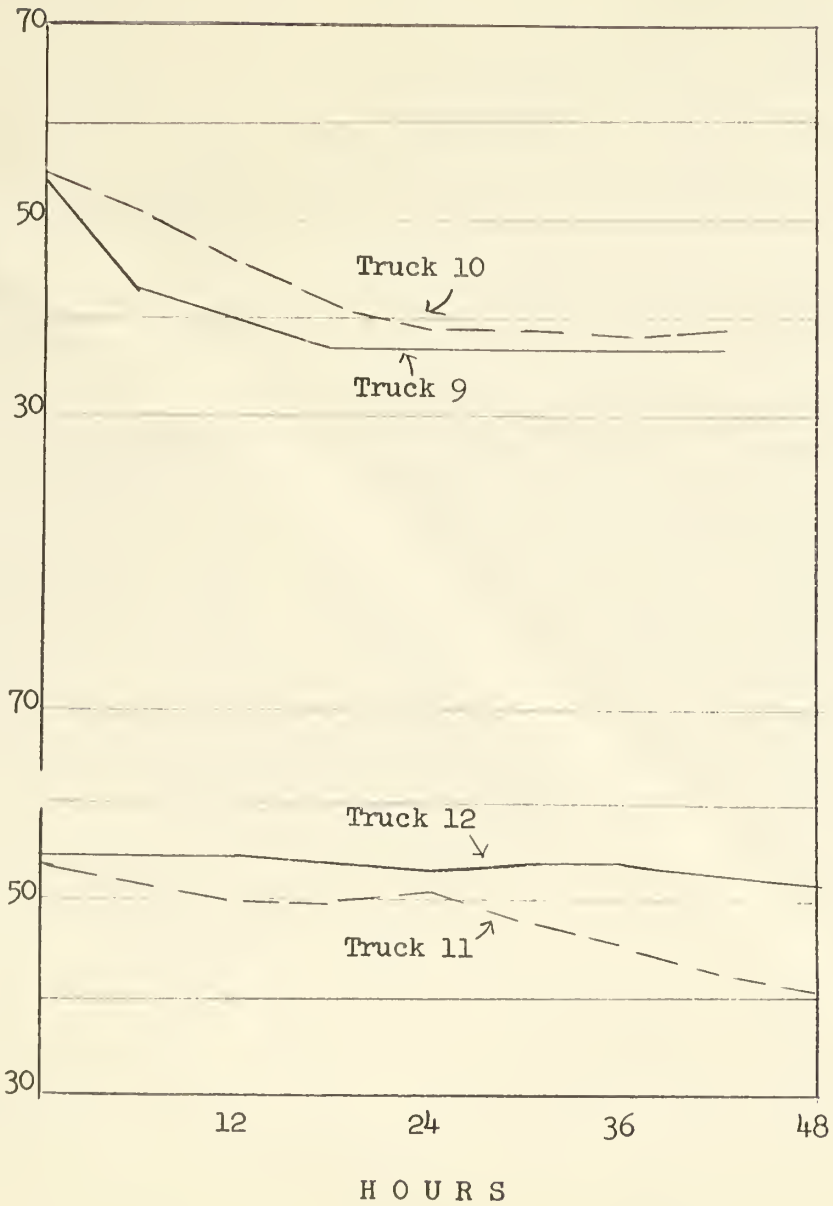

Figure 8.

Transit temperatures (average for three positions) in a modified lengthwise top-iced load (truck 9) and in a conventional lengthwise top-iced load (truck 10), October 1953.

Figure 9.

Transit temperatures (average for two positions) in a modified lengthwise top- and bunker-iced load (truck 12) and in a conventional lengthwise top- and bunker-iced load (truck 11), November 1953.